

REMARKS

Applicants have amended their claims in order to further clarify the definition of various aspects of the present invention. Specifically, Applicants have amended claim 1 delete "an epoxy resin having a glycidyl ether part derived from bisphenol F" from the list of epoxy resins of the epoxy resin composition of the coating layer.

Claim 1 has been further amended to include therein that the coating layer contains a skeletal structure represented by formula (1), in an amount of 30% by weight or more based on the weight of the coating layer (note original claim 3).

In light of amendments to claim 1, and noting claim 6, claims 3 and 5 have been cancelled without prejudice or disclaimer.

Applicants respectfully submit that all of the claims presented for consideration by the Examiner patentably distinguish over the teachings of the prior art applied by the Examiner in the Office Action mailed February 6, 2007, that is, the teachings of the U.S. patents to Gerdes, et al., No. 4,719,135, to Carlblom, No. 5,637,365, to Huang, et al., No. 3,683,044, and to Tashiro, et al., No. 3,704,229, under the provisions of 35 USC 103.

It is respectfully submitted that these references as applied by the Examiner would have neither taught nor would have suggested such a fuel system as in the present claims, having the coating layer as recited in claim 1, the coating layer being formed by coating an epoxy resin composition comprising (a) an epoxy resin and (b) an epoxy resin curing agent as principal components, the coating layer having the specified gasoline permeability coefficient, and wherein the epoxy resin includes at least one selected from an epoxy resin having a glycidylamine part derived from metaxylylenediamine, and an epoxy resin having a glycidylamine part derived from 1, 3-bis(aminomethyl)-cyclohexane; wherein the epoxy resin curing agent comprises

a reaction product of the following (A) and (B) or a reaction product of the following (A), (B) and (C):

- (A) metaxylylenediamine or paraxylylenediamine;
- (B) a multifunctional compound having at least one acyl group which can form an amide group part by reacting with polyamine to form a oligomer, the multifunctional compound being selected from the group consisting of acrylic acid, methacrylic acid, and derivatives of acrylic acid, methacrylic acid, maleic acid, fumaric acid, succinic acid, malic acid, tartaric acid, pyromellitic acid and trimellitic acid; and
- (C) monovalent carboxylic acid having 1-8 carbon atoms and/or a derivative thereof,

and wherein the coating layer contains the skeletal structure of formula (1), at least in an amount of 30% by weight based on the weight of the coating layer. See claim 1.

In addition, it is respectfully submitted that the teachings of the applied references would have neither disclosed nor would have suggested such fuel system as in the present claims, having features as discussed previously in connection with claim 1, and additionally wherein the gasoline permeability coefficient is 0.2g \cdot mm/m² \cdot day or less (see claim 2); and/or wherein the epoxy resin composition cured to form the coating layer includes the epoxy resin as in claim 6; and/or wherein the multifunctional compound (B) reacted in forming the epoxy resin curing agent is that set forth in claim 8; and/or area rate of the coating layer formed on the fuel vessel body, as in claim 9; and/or materials of the fuel vessel body or fuel vessel or molded part bodies, as in claims 10-14; and/or wherein the fuel system includes a tube body as in claim 15, with material of the tube body as in claim 16, especially

with blending proportions of the epoxy resin curing agent to epoxy resin as in claim 17; and/or wherein the coating layer is formed on at least one of the connected parts as in claim 18; and/or reaction mole ratio of components of the curing agent as in claim 19; and/or blending proportion of epoxy resin curing agent to epoxy resin as in claim 20; and/or thickness of the coating layer as in claim 21; and/or wherein the multifunctional compound reacted in forming the curing agent, is selected from the group consisting of the derivatives set forth in claim 1 (see claim 22).

The present invention is directed to a fuel system which includes at least one of various components such as, for example, a fuel vessel, molded parts for the fuel vessel and a tube for a fuel. In particular, the present invention is directed to such fuel system having excellent performance in preventing permeation of, e.g., gasoline, while having good heat resistance and impact resistance.

In recent years, use has been made of thermoplastic resins in fuel systems, as compared with use of metal, providing advantages of a reduction in weight, prevention of rust, ease in molding and ability to be recycled. However, in previously proposed fuel systems, various performances, such as heat resistance, water resistance, impact resistance, and avoidance of permeation of gasoline, has not been sufficiently satisfactory.

Against this background, Applicants provide a fuel system excellent in gasoline barrier property, heat resistance and impact resistance, and which also (when used in forming a tube of, e.g., rubber) has excellent flexibility. Moreover, the fuel system can be provided at relatively inexpensive cost, insuring a high profitability. Applicants have found that by forming the fuel system utilizing a thermoplastic resin and/or a rubber as the body of the fuel system, and providing a coating layer on at least one side of the body, the coating layer being formed by

curing an epoxy resin composition including a specified epoxy resin and a specified epoxy resin curing agent, the coating containing a specified amount of the skeletal structure of general formula (1), as in present claim 1; and wherein the coating layer has a gasoline permeability coefficient of 2 g·mm/m²·day or less at 60°C in a relative humidity of 60%RH, objectives according to the present invention are achieved. In particular, an excellent gas barrier property is achieved, the fuel system has excellent heat and impact resistance, the coating layer has excellent adhesiveness to the body of thermoplastic resin, and the fuel system can be provided relatively inexpensively.

In particular, as described on pages 23 and 24 of Applicants' specification, by utilizing the specified epoxy resin curing agent, and epoxy resin, in the epoxy resin composition cured to form the coating layer, the coating layer having at least 30% by weight (of the total weight of the coating layer) of the skeletal structure of general formula (1), as in the present claims, a good adhesiveness of the coating layer to various materials, high gasoline barrier property, flexibility and heat resistance are achieved.

Note, e.g., the paragraphs bridging pages 18 and 19, and 19 and 20, of Applicants' specification.

Note that the multicomponent compound of (B) and the monovalent carboxylic acid of (C) respectively include compounds having at least one acyl group which can form an amide group part by reacting with polyamine to form an oligomer, the multifunctional compound being selected from a specified group of acids and derivatives, and monovalent carboxylic acids having 1-8 carbon atoms and/or a derivative thereof. As for these components (B) and (C), note the paragraph bridging pages 23 and 24, as well as the sole full paragraph on page 24, of

Applicants' specification, describing illustrative specific materials as well as the derivatives.

Initially, note that the Examiner has not rejected claim 3 over the combined teachings of Gerdes, et al., Huang, et al. and Tashiro, et al. Note Item 4 on pages 2-5 of the Office Action mailed February 6, 2007. Again emphasizing that subject matter of claim 3 has been incorporated into claim 1, it is respectfully submitted that the rejection of claims as set forth in Item 4 on pages 2-5 of the Office Action mailed February 6, 2007, is moot.

With respect to the rejection as set forth in Item 5 on pages 5 and 6 of the Office Action mailed February 6, 2007, Gerdes, et al. discloses a coated polymeric article, e.g., a polyethylene substrate, having reduced permeability for fuels, particularly gasoline-type fuels, and characterized by a two component, preferably three component, varnish coat comprising: (a) an epoxy resin, e.g., preferably having an epoxy equivalent weight of about 150-280, (b) an effective amount of a specified amine-based curing agent as set forth in lines 3-11 of column 2, and preferably a third varnish component which is a flexibilizer, e.g., a suitable amount of isocyanate prepolymers, e.g., one based on an isocyanate prepolymer containing ether groups and urethane groups. Note the paragraph bridging columns 1 and 2 of this patent. See also column 2, lines 37-41. This patent discloses that suitable epoxy resins are those containing more than one epoxide group, e.g., 1.5-5, in the monomeric unit. See column 2, lines 56-58. Note also column 2, lines 59-68, for particularly suitable epoxy resins. Note also column 3, lines 1-35, for curing agents for use in forming the fuel impervious polymeric article of Gerdes, et al.

It is respectfully submitted that Gerdes, et al. requires an amine-based curing agent as set forth in column 2, lines 1-11; and it is respectfully submitted that this

reference does not disclose, nor would have suggested, wherein the epoxy resin composition cured to form the coating layer includes an epoxy resin curing agent as in the present claims, comprising a reaction product of (A) and (B) or reaction product of (A), (B) and (C), or wherein the coating layer has the recited gasoline permeability coefficient, or other features of the present invention, including the epoxy resin and skeletal structure of general formula (1) of the coating layer (much less the amount of skeletal structure of general formula (1) in the coating layer).

It is respectfully submitted that the additional teachings of the secondary references as applied by the Examiner would not have rectified the deficiencies of Gerdes, et al., such that the presently claimed invention as a whole would have been obvious to one of ordinary skill in the art.

Tashiro, et al. discloses epoxy resin compositions having room temperature curability, the curing agent being sufficiently curable even in a wet state and having an improved compatibility with tar. The curing agent disclosed in this patent can be obtained by addition and condensation reactions of three components A, B and C, A being an acrylic or methacrylic acid ester, B being one of slightly water-soluble or insoluble aliphatic amines having a primary amine radical or an amine mixture thereof, and C being (a) a xylylenediamine having a specified structural formula and having both properties of aliphatic amine and aromatic amine, and (b) a 70:30 mixture of metaxylylenediamine and paraxylylenediamine. See column 1, line 59 though column 2, line 16. Note also column 2, lines 17-49, describing how the components A-C of the curing agent are reacted.

Carlblom discloses resins having gas barrier properties, and packaging materials and/or containers including barrier coatings, this patent disclosing that the barrier coatings substantially reduce permeability of gasses such as carbon dioxide

and/or oxygen through the packaging materials. The coatings disclosed in this patent are the cured reaction product of a polyamine with a polyepoxide having a specified structure. See column 2, lines 34-45. This patent discloses a packaging material being provided which includes at least one layer of a relatively gas-permeable polymeric material and at least one layer of a polyamine-polyepoxide barrier coating as disclosed in this patent. See column 4, lines 1-5. Note also the paragraph bridging columns 5 and 6 of this patent. Note also column 7, lines 41-51; and column 8, lines 51-53. See also column 10, lines 18-24.

Huang, et al. discloses a heat-curable resinous composition comprising polyglycidyl xylylenediamine, obtained by the reaction between xylylenediamine and epichlorohydrin. This patent document discloses that the disclosed material has a relatively low viscosity resulting in a good workability, and gives cured products exhibiting a high heat distortion temperature. Note column 1, lines 6-9 and 61-67. Note also column 4, lines 21-25. Huang, et al. discloses that the polyglycidyl xylylenediamine can be readily cured with the aid of curing agents customarily used for curing of glycidyl compounds, such as aliphatic or aromatic polyamines and organic carboxylic anhydrides. Note column 4, lines 37-41. This patent further discloses that the polyglycidyl xylylenediamine provides an industrial material exhibiting a low viscosity suitable for adhesive and casting, and a cured product prepared therefrom shows a high heat resistance. See column 5, lines 19-25.

Initially, it is respectfully submitted that the teachings of Gerdes, et al., as applied by the Examiner, would not have been properly combinable with the teachings of Tashiro, et al. or Carlblom, or Huang, et al. Thus, it is noted that Gerdes, et al. is directed to a fuel impervious polymeric article, facing the problem of providing such article without a primer or adhesion promoter. In contrast, Carlblom

is directed to gas (such as oxygen and carbon dioxide) barrier coatings for use in packaging materials, addressing the problem of providing a barrier coating reducing the permeability of gasses such as carbon dioxide and/or oxygen through the packaging materials. Tashiro, et al. is directed to an epoxy resin curing agent which is sufficiently curable even in a wet state and having an improved compatibility with tar. Huang, et al. is directed to a heat-curable resin compositions comprising polyglycidyl xylylenediamine, with a relatively low viscosity and high heat distortion temperature, suitable for adhesives and coatings, without disclosure of fuel permeability. It is respectfully submitted that none of Tashino, et al., Huang, et al. and Carlblom disclose fuel permeability (i.e., fuel barrier properties). In view of differences in technology in the teachings of the applied references, particularly with respect to the teachings of Gerdes, et al. and of Carlblom, and further in view of differences in problems addressed by each of these references, it is respectfully submitted that one of ordinary skill in the art concerned with in Gerdes, et al. would not have looked to the teachings of Tashiro, et al. or of Huang, et al. or of Carlblom, and particularly would not have looked to the teachings of Carlblom. In other words, it is respectfully submitted that the teachings of these references are directed to non-analogous arts.

In any event, particularly in view of the differences in technology in the teachings of the applied references, and also in view of differences in problems addressed by each, it is respectfully submitted that there would have been no proper motivation for combining the teachings of these applied references, as applied by the Examiner. Absent such motivation, it is respectfully submitted that the combination of teachings of these references as applied by the Examiner is improper under the guidelines of 35 USC 103, using impermissible hindsight.

The contention by the Examiner that Carlblom teaches structure for a fuel container, referring to column 1, lines 31-33, thereof, is noted. See the third paragraph of Item 5, on page 5 of the Office Action mailed February 6, 2007. However, it is emphasized that Carlblom discloses, as the background of the invention therein, that, in addition to food applications, barrier coatings have utility for plastic medical ampoules and the like and for plastic fuel containers. More importantly, note column 4, lines 23-27 of Carlblom, describing that by the term "barrier material" as used throughout the description therein, "is meant that such a material has a low permeability to gases such as oxygen and/or carbon dioxide, i.e., the material exhibits a high resistance to the passage of oxygen or carbon dioxide through the material". This patent goes on to describe, in column 4, lines 32-34, that "low permeability to either carbon dioxide or oxygen as defined below is sufficient to qualify the material as a 'barrier material'". Thus, while, in the background of the invention, Carlblom discloses use of barrier coatings in general for plastic fuel containers, the barrier material described in Carlblom, taking the disclosure of Carlblom as a whole, is directed to a material exhibiting high resistance of the passage of oxygen or carbon dioxide. It is respectfully submitted that the disclosure of this patent does not teach, nor would have suggested, resistance to passage of gasoline or like fuel; and it is respectfully submitted that one of ordinary skill in the art concerned with in Gerdes, et al. would not have looked to the teachings of Carlblom, as discussed previously.

In any event, even assuming, arguendo, that the teachings of Gerdes, et al., Tashiro, et al., Huang, et al. and Carlblom were properly combinable, it is respectfully submitted that such combined teachings would have neither disclosed nor would have suggested the presently claimed invention, including, in addition to

the recited epoxy resin curing agent, wherein the coating layer includes an epoxy resin comprising at least one selected from an epoxy resin having a glycidylamine part derived from metaxylylenediamine or from 1,3-bis(aminomethyl)cyclohexane, or the coating layer having the specified curing agent, or the skeletal structure of general formula (1) in the coating layer, especially amount thereof, and advantages achieved thereby.

The contention by the Examiner in the third paragraph of Item 5, on page 5 of the Office Action mailed February 6, 2007, that Carlblom teaches an epoxy, the Examiner pointing to column 8, lines 60-63 of Carlblom, is respectfully traversed. First, it is respectfully submitted that there is no description regarding "an epoxy comprising a glycidylamine part derived from metaxylylenediamine" (emphasis added) in column 8, lines 51-60. What is taught in this portion is the residues which constitute the cured polymeric network. It is noted that the residue disclosed in column 8, line 55, is taught to be derived from xylylenediamine, and is not taught to be derived from an epoxy resin comprising a glycidylamine part derived from metaxylylenediamine.

It is respectfully submitted that the coatings of Carlblom are the cured reaction product of a polyamine with a polyepoxide having the structure set forth in line 45 of column 7, or the structure set forth in line 55 in column 7. It would appear from these structures that the polyepoxides of Carlblom include no polyamine residue. Thus, contrary to the contention by the Examiner, it is respectfully submitted that the polyepoxide of Carlblom does not have a glycidylamine part derived from metaxylylenediamine.

In addition, it is respectfully submitted that Carlblom teaches that the polyamines such as xylylenediamine are for reacting with the polyepoxides, for

curing the coatings. Note the paragraph bridging columns 2 and 3 of Carlblom.

Namely, it is respectfully submitted that Carlblom teaches that xylylenediamine is used as a curing agent for the polyepoxides, not a component for constituting the polyepoxide.

In view of the foregoing, it is respectfully submitted that the Examiner errs in construing Carlblom as describing an epoxy including a glycidylamine part derived from metaxylylenediamine; and that, properly construed, the teachings of the applied references would have neither disclosed nor would have suggested the presently claimed subject matter, including, inter alia, the epoxy resin used in forming the coating layer of the present claims, much less wherein the coating layer is a product of such epoxy resin and the specific curing agent as in the present claims, and wherein the coating layer has the gasoline permeability as in the present claims, or skeletal structure in the coating layer and amount thereof in the coating layer, and advantages thereof.

Furthermore, note that presently amended claim 1 recites that the epoxy resin can also be an epoxy resin having a glycidylamine part derived from 1,3-bis(aminomethyl)cyclohexane. In contrast, Carlblom discloses that the residues constituting the cured coating include phenylene or naphthylene. Clearly, Carlblom teaches away from using a diamine having an alicyclic ring structure, as in one of the epoxy resins in the present claims.

The additional contention by the Examiner in the third paragraph of Item 5, on page 5 of the Office Action mailed February 6, 2007, that Carlblom teaches an epoxy having the claimed structure "in then amount of 30% by weight (bisphenol in the amount of 30% by weight; column 6, lines 63-65) is respectfully traversed. In column 8, lines 60-63 of Carlblom, this patent teaches that the combination of groups set

forth in column 8, lines 59-64, comprise at least 65% by weight of the cured network. It is respectfully submitted that Carlblom does not disclose, nor would have suggested, that the claimed structure of formula 1 is contained in the cured network in an amount of 30% by weight. The Examiner is respectfully requested to point the specific portion of Carlblom, showing the claimed structure of formula 1 being contained in the cured network in an amount of at least 30% by weight, based on the weight of the coating layer.

In particular, and as shown below, it is respectfully submitted that Carlblom fails to teach the cured network in which the content of $>\text{N}-\text{CH}_2-\Phi-\text{CH}_2-\text{N}<$ groups is 30% by weight or more.

Thus, Adduct A (column 13, lines 25-37) in Carlblom contains no m-xylylenediamine (MXD). Adduct B is a reaction product of 68 g of MXD and 112 g of resorcinol diglycidyl ether (column 13, lines 40-51 of Carlblom). Therefore, the MXD content of Adduct B amounts to 38% ($68/(68 + 112)$).

According to U.S. Patent No. 4,605,765, a copy of which is attached hereto, referred to in column 7, lines 13-17 of Carlblom, Gaskamine 328 (a reaction product of MXD and epichlorohydrin) is represented by formula shown at column 2, line 10 of No. 4,605,765. The MXD content of Gaskamine 328 is calculated from the above formula to be 40% by weight ($132/328$).

Using the above MXD contents of curing agents, the MXD content in the cured products of Examples 1-8 taught by Carlblom have been calculated, and are shown in the lower Table enclosed herewith in an Appendix, values in the lower Table being calculated from values in the upper Table of this Appendix.

As evidenced by the results in the lower Table, all the cured products in the Examples of Carlblom fail to contain the claimed structure in the claimed amount. It

is respectfully submitted that the Examiner errs in concluding that the teachings of the applied references, including Carlblom, would have taught or would have suggested the presently claimed fuel system, including the skeletal structure represented by formula (1) being contained in an amount of 30% by weight or more based on the weight of the coating layer. To the contrary, it is respectfully submitted that the combined teachings of the applied references, including Carlblom, would have neither taught nor would have suggested the presently claimed subject matter, including the coating layer having the specified amount of the skeletal structure represented by formula (1), and advantages thereof.

In addition, and as acknowledged by the Examiner in the paragraph bridging pages 2 and 3 of the Office Action mailed February 6, 2007, Gerdes, et al. fails to disclose, inter alia, an epoxy resin having a glycidylamine part derived from metaxylylenediamine. It is respectfully submitted that the other applied references also fail to teach epoxy resins having a glycidylamine part as in the present claims. Thus, Tashiro, et al. fails to teach the claimed glycidylamines, describing glycidyl ethers derived from bisphenol A, for example. Carlblom teaches nothing about the curing of the claimed glycidylamines. The Examiner has relied on Huang, et al. as disclosing polyglycidyl xylylenediamines. However, it is respectfully submitted that Huang, et al. does not disclose gasoline barrier properties of the cured products. Taking the teachings of the applied prior art in combination, it is respectfully submitted that there would have been no disclosure, nor any suggestion, of the superior gas barrier properties of the presently claimed coating layer, having, inter alia, the epoxy resin comprising at least one selected from an epoxy resin having a glycidylamine part derived from metaxylylenediamine and an epoxy resin having a

glycidylamine part derived from 1,3-bis(aminomethyl)-cyclohexane, as in the present claims.

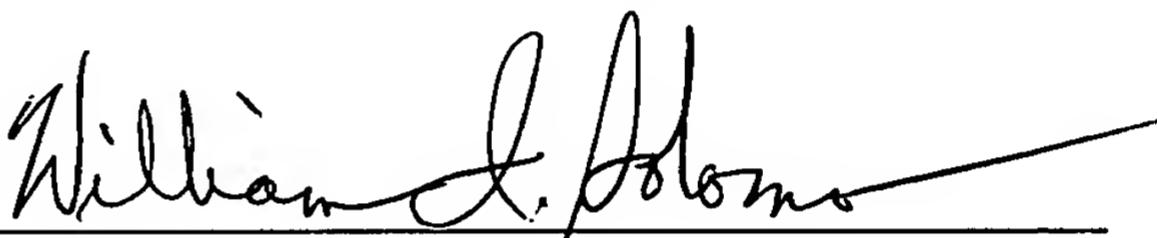
In view of the foregoing comments and amendments, reconsideration and allowance of all claims remaining in the application are respectfully requested.

Applicants request any shortage in fees due in connection with the filing of this paper be charged to the Deposit Account of Antonelli, Terry, Stout & Kraus, LLP, Deposit Account No. 01-2135 (case 396.42795X00), and credit any excess payment of fees to such Deposit Account.

Respectfully submitted,

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Enclosures: U.S. Patent No. 4,605,765; Appendix (1 pg., 2 Tables)

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APPENDIX

Calculated values from
Examples 1-8 of Carlblom

Examples	Amine		Epoxy	
	type	MXD content (wt %)	type	MXD content (wt %)
1	Adduct A	0	Heloxy 69	0
2	Adduct B	38	Heloxy 69	0
3	Gaskamine 328	40	Heloxy 69	0
4	Gaskamine 328	40	Epon 828	0
5	MXDA	100	Heloxy 69	0
6	MXDA	100	Heloxy 69	0
7	Adduct B	38	Epi-Rez A-100	0
8	Adduct B	38	Heloxy 69	0

Examples	Wt. ratio Amine/Epoxy	MXD content in cured product (wt %)
1	10/12.9	0
2	10/6.4	$(10 \times 0.38)/(10 + 6.4) \times 100 = 23$
3	10/23.6	$(10 \times 0.4)/(10 + 23.6) \times 100 = 12$
4	10/33.6	$(10 \times 0.4)/(10 + 33.6) \times 100 = 9$
5	10/29.4	$10/(10 + 29.4) = 25$
6	10/28.7	$10/(10 + 28.7) = 26$
7	10/8.5	$(10 \times 0.38)/(10 + 8.5) \times 100 = 21$
8	10/6.2	$(10 \times 0.38)/(10 + 6.2) \times 100 = 23$